LEIBNIZ INSTITUTE FOR BALTIC SEA RESEARCH WARNEMÜNDE

Leibniz Institute for Baltic Sea Research Warnemünde

Cruise Report

r/v "ALKOR "

Cruise- No. AL 449

This report is based on preliminary data

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1. **Cruise No.:** AL449

2. **Dates of the cruise:** from 31.01.2015 to 12.02.2015

3. **Particulars of the research vessel:**
   Name:
   Nationality: Germany
   Operating Authority: GEOMAR

4. **Geographical area in which ship has operated:**
   Baltic Sea, Bay of Gdansk

5. **Dates and names of ports of call**
   Gdansk Harbour

6. **Purpose of the cruise**
   Biogeochemical cycling of nutrients in the coastal area of the Baltic Sea in the vicinity of a major Baltic Sea River, Vistuls River, in the framework of the BONUS project COCOA, nutrient cocktail in the coastal zone

7. **Crew:**
   Name of master: Peter Lass
   Number of crew: 11

8. **Research staff:**
   Chief scientist: Maren Voss

   Scientists: 11

   Engineers: 0

   Technicians: 1

9. **Co-operating institutions:**
   University Helsinki Finland, University Gdansk Poland, University Aarhus with Technical University and Aarhus University in Denmark

10. **Scientific equipment**
    CTD, Multicorer, Haps corer, Van Veen grab, mooring with ADCP

11. **General remarks and preliminary result** (ca. 2 pages)

Short narrative of the cruise

We left Warnemünde pier at January 31st with scientists from Denmark, Finland, Poland and Germany. After a smooth journey of a bit more than one day we reached the Bay of Gdansk where some wind and waves forced us to work in the inner bay first. We completed a transect of three stations from close to the Vistula mouth to the open bay. A long term station at VE02 with the deployment of a mooring to measure currently and turbidity was then deployed only 2.3 nautical miles north west of the river mouth. After that day, on February 5th, we could continue with the Gdansk deep station with 100 m water depth. Interestingly the water column of that station was fully oxygenated and also the sediments were covered by a thick brown layer clearly indicating the presence of oxygen over the past month. The same was found at app. 80 m depth although the sediments below remained highly sulfidic. After completing the entire transect we decided to work east of the river mouth where the plume of the Vistula River mostly expands.

Sandy sediments are the most challenging ones to collect but we tried and station VE09 was especially difficult so that we changed from the multi corer to the use of the Haps corer instead. Nevertheless we completed this transect at least with water sample collection at the stations VE13 and VE12. A major storm was approaching the next day so that we could not start another long-term mooring. We headed for the spot where we had encountered coarse sand the previous summer, station VE49a, but unfortunately failed to collect any cores. Due to the increasing gales we decided to visit the more sheltered station off Hel Peninsula to collect samples from a Polish monitoring station. We could barely complete the sample washing on deck before the wind picked up so hard that work on deck was impossible. Within an hour we reached Gdynia harbor at around 14:00UTC and stayed there until Monday morning. Snow, hail and very strong winds were blowing and it remained ice cold.

Still high waves prevented us from collection of sediments with the heavy multicorer but we could deploy the ADCP again at station VE02. The next day was calm, sunny and beautiful and we completed the station work successfully. It turned out that the storm had resulted in much deeper oxygen penetration into the sediments as it was before on February 3rd. The comparison of data from this station before and after storm will be one highlight of the data evaluation over the coming month. Finally after returning the Gdynia once more to deliver our Polish colleagues to harbor we started sailing home in the afternoon of February 10th.

Research Goals and Preliminary Results:

Data of temperature and salinity revealed a significant impact of the Vistula River plume on the nutrient geochemistry in the vicinity of the river mouth. Altogether 13 different stations were visited, one station was sampled twice (Figure 1, Appendix). However, we concentrated our work on the stations with impact of plume waters in the surface to ones with clearly no impact which were located on a transect out of the Bay. The surface properties of the water column were monitored with the ships thermosalinograph and clearly reveal a spreading of the river plume towards the west along the coastline. This finding is in accordance with previous observations where the plume was visible along the eastern coastline of the Bay of Gdanks. Since the weather was usually a bit rough during the cruise we worked close to the coast during the first days. Our routine on each station were CTD casts first with an EXO sensor mounted to the frame, sample collection during several casts. Afterwards sediments for denitrification experiments were collected as well as the water above the cores for nitrification measurements in the bottom near nephloid layer and finally the fauna was collected with a grab. At the station VE 02 a mooring system with ADCP was deployed twice for 24 hours.

The research group 'Marine Nitrogen Cycle' of the Leibniz Institute for Baltic Sea Research studied coastal nitrogen transformation processes. Water samples were taken from the CTD and the sediment cores (overlaying water) in order to determine nutrient concentrations, oxygen concentrations, chlorophyll a content, particulate organic matter concentration and isotopic composition. Moreover dissolved organic nitrogen and the isotopic composition of nitrate and nitrite shall be measured. Nutrient and oxygen concentrations could be measured immediately on the ship by Christian Burmeister. They revealed highest nitrate concentrations at the station VE03 with 78µmol l^{-1} (Figure 3). For isotopic analyses as well as DON-determinations the water samples were filtered over pre-combusted GFF-filters and stored at -20°C until measurement in the institute. The pre-combusted GFF-filters are used for C/N analyses and were also frozen. For the Chl. a measurements water was filtered over GFF-Filters and filters are frozen at -20°C. Furthermore, water samples for the measurement of N_2O concentrations from the bottom water layer were taken by Anna Brüggemann and will be analysed in the lab of Prof. Rehder at IOW.

Ines Bartl studied nitrification in the Vistula estuary and the Gulf of Gdansk, especially along the river plume and the benthic boundary layer (overlaying water from sediment cores) along a depth gradient. Surface water samples from the river plume to more saline water were taken at 6 stations and the sediment overlying water samples were taken at 7 stations along a north-south transect and an east west transect (also covering the area of the river plume). To determine nitrification rates incubation experiments were conducted using 15N labelled ammonium and the 'denitrifier-method' to detect the 15N in the produced nitrate. Furthermore ammonium assimilation will be determined using the precombusted GFF-Filters after filtration of the incubated water at the end of incubation. The samples will be later analysed in the lab at IOW.

The research group "Nutrient cycles in aquatic ecosystems" of the University of Helsinki (PI Academy Research Fellow Susanna Hietanen) and PhD student Dana Hellemann studied denitrification in the Vistula estuary on 12 stations using 15N-labelled nitrate in the Isotope Pairing Technique. Experiments were run for both sandy (permeable) and muddy sediments with samples collected using a HAPS corer and a Multicorer, respectively. On the 6 sandy stations a newly developed advective flow incubation system was tested against the traditional diffusive system. In the advective flow incubation system a water flow was applied on top of the sediment samples to create pressure difference onto the surface that would press the water into the sediment and mimic advective conditions.

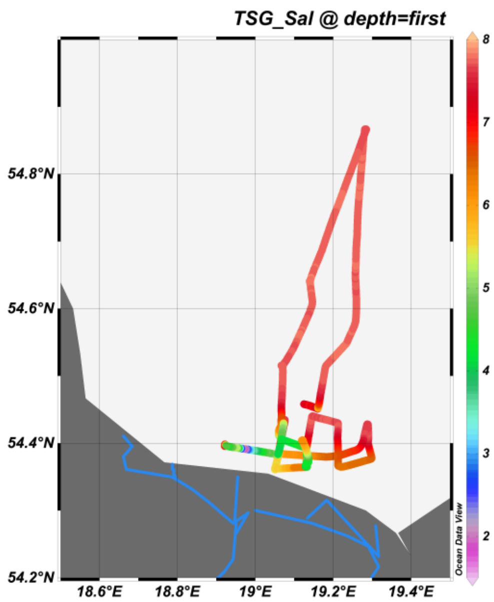

Figure 2 surface data of the salinity along the transects including in between steaming close to the mouth of the Vistula River

The advective layer depth was determined from three replicate oxygen profiles recorded for each sandy station using Unisense microelectrodes OX-250 with a resolution of 500 µm before starting the incubations, and again after the incubations. On muddy stations the oxygen profile was recorded using OX-100 microelectrodes with a resolution of 250 µm. In addition, samples to determine porosity and permeability were collected from these stations. The results of the experiments will enable clarifying the roles of permeable and non-permeable sediments in decreasing the nitrogen load transported from the Vistula River towards to open Baltic Sea.

Heather Reader, Institute of Aquatic Resources, Technical University of Denmark (DTU-Aqua) studied DOM dynamics in the coastal zone. The potential and dynamics of dissolved organic matter (DOM) fluxes from coastal sediments was investigated. Coastal sediments have the potential to turnover large amounts of organic carbon, but also to release DOM into the water column. The magnitude of this release is poorly characterized, as is the reactivity of the DOM that is released to the water column. To better understand the magnitude and character of the DOM release from coastal sediments the following sampling program was undertaken.

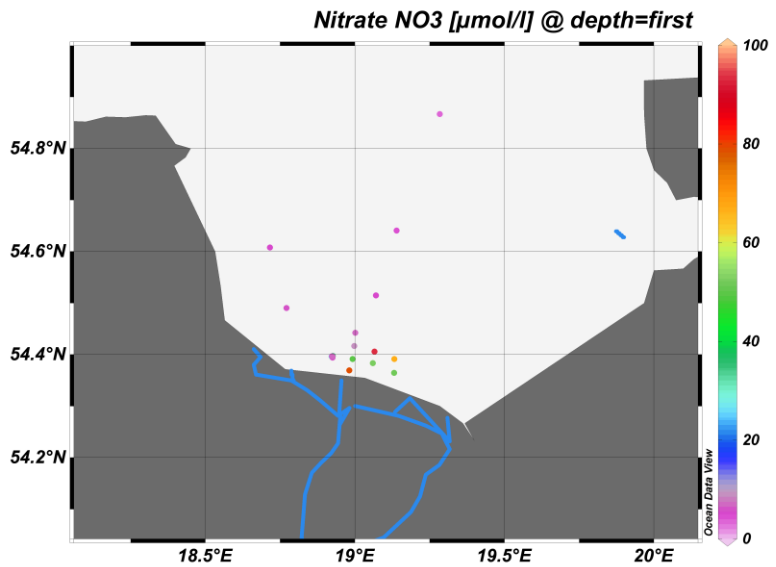

Figure 3 surface water nitrate concentrations

Water column (from the CTD rosette) DOM samples were taken for dissolved organic carbon, chromophoric DOM, fluorescent DOM, dissolved organic phosphorus, and biological availability of DOM. In addition, samples for the above analyses were taken from the water overlaying the sediments as well. A total of 102 samples were taken. Samples of sediment (multicorer samples, 12 stations) were taken from the top 1 cm of the sediment core and DOM was stripped from the cores using a short shipboard incubation. DOM characterization will also be performed on these samples as with the water column samples. Preliminary characterization of these samples indicates a high amount of DOM release.

All samples for dissolved organic carbon, chromophoric DOM, fluorescent DOM, and biological availability will processed at DTU-Aqua (estimated time for analysis: 2 months). Samples for dissolved organic phosphorus will be analysed at the Finnish Environment Institute by Kaarina Lukkari.

Sampling of Eero Asmalas work had three major objectives: 1) to quantify the distribution of humic-like DOM signal in the surface waters of the Vistula plume, 2) to link the growth efficiency of the bacterial community in relation to its excretion of fluorescent DOM, and 3) to quantify the flocculation potential of the Vistula river water when subjected to saltwater. All these approaches give insight about the DOM dynamics in an estuary. High spatial resolution of humic-like DOM and the possible deviations from the conservative mixing line enable the examination of the significance of Vistula plume to the DOM pool in the Gulf of Gdansk. As bacterial growth efficiency varies significantly between seasons and in different nutrient conditions, it is likely to have an effect of the DOM dynamics of the bacterial community as well. Flocculation phenomenon is a well-established phenomenon in estuarine systems, but quantified approaches are rare. In the Baltic Sea, it is very likely that different rivers with different starting points exhibit varying potential for organic matter flocculation. To achieve these goals humic-like DOM was measured continuously (frequency 1 min^{-1}) along the ship's route. The measurements were carried out with a multisonde connected to a flow-through system. The sensors measured among others humic-like fluorescence of DOM, salinity and pH. The readings acquired from the sensor will be calibrated with discrete water samples collected from the same flow-through system.

Bacterial growth efficiency (BGE) experiment was carried out with 7-10 d bioassays, where 0.8 µm-filtered water was incubated. The filtration includes the bacterial community in the sample, but removes majority of bacteriovores and larger particles. The bioassays were manipulated in 2×2 factorial experiment (inorganic nutrient additions × elevated temperature) in order to get different responses in growth efficiency from same DOC source. BGE will be quantified by measurements of oxygen, DOC, POC and bacterial cell numbers. Inferred BGE will later be linked with changes in DOM quality (such as DOM absorbance, fluorescence and molecular size). Flocculation was studied simply by mixing river water from Vistula with seawater made from Milli-Q and artificial sea salt. The mixing was done in a series of end salinities ranging from 0.0 to 20.0. Changes in DOM quantity and quality after the salt water addition result as the flocculation potential. Humic-like DOM was followed continuously along the ship's route. Following stations were included in the BGE study: TF233, VE02, VE04, VE05, VE06, VE07, VE09, VE10, VE12, VE13, VE38, VE39 and VE49a. Moreover, flocculation potential was tested from a single natural water source, Vistula river.

Anna Dabrowska and Magdalena Machuta from the Department of Experimental Ecology on Marine Organisms at the Institute of Oceanography of the University of Gdansk collected fauna from most stations (Table 1). We sampled on stations in the Gulf of Gdansk, with particular focus on the Vistula plum area and three deep stations (the Gdansk Deep and the Puck Bay area).

Table 1: sampling stations for collection of fauna

No.	Number of station	Date	Approximate depth [m]
1	VE02	03/04.02.2015 and 09/10.02.2015	24
2	VE04	01.02.2015	15
3	VE05	01.02.2015	24
4	VE06	02.02.2015	38
5	VE07	02.02.2015	60
6	VE09	06.02.2015	35
7	VE10	03.02.2015	24
8	VE13	06.02.2015	30
9	VE38	05.02.2015	73
10	VE39	05.02.2015	90
11	VE46a	07.02.2015	50
12	TF233	05.02.2015	106

Only one station- VE49a was skipped for benthic fauna sampling, because of technical problems. At station VE02 we sampled two times= on 3rd and 9th February. Samples will be used to compare benthic community before and after storm, which took place between 7th and 9th February.

For benthic fauna analysis, following samples were taken:

- sediment cores, which were sliced into layers: 0-1, 1-3, 3-6, 6-10, 10-15, >15cm, then sieved on 1mm sieve and preserved with formaldehyde for further analysis of macrofaunal burial depth,

- van Veen grabs, sieved on 1mm sieve and preserved with formaldehyde for further analysis of taxonomic composition of fauna community on different kinds of sediments.

On the first sight, before detailed analysis in laboratory, significant differences between stations were observed, mainly depending on depth of station and kind of sediment. On very deep stations (around 60m and deeper), only one or two species are likely to occur and on shallower stations (coastal ones, between 15 and 30 m), much more diverse communities are expected. On sandy sediments, there will probably be more mussels and crustaceans and on muddy sediments- bioturbating polychaetes will dominate.

Benthic fauna analysis from this cruise will be later combined with chemical analysis (carbon, nitrogen, sulphide content, water content and pore water profiles) of sediment cores from all stations and suspension results from stations VE38, VE46a and TF233.

Appendix: map and list of stations

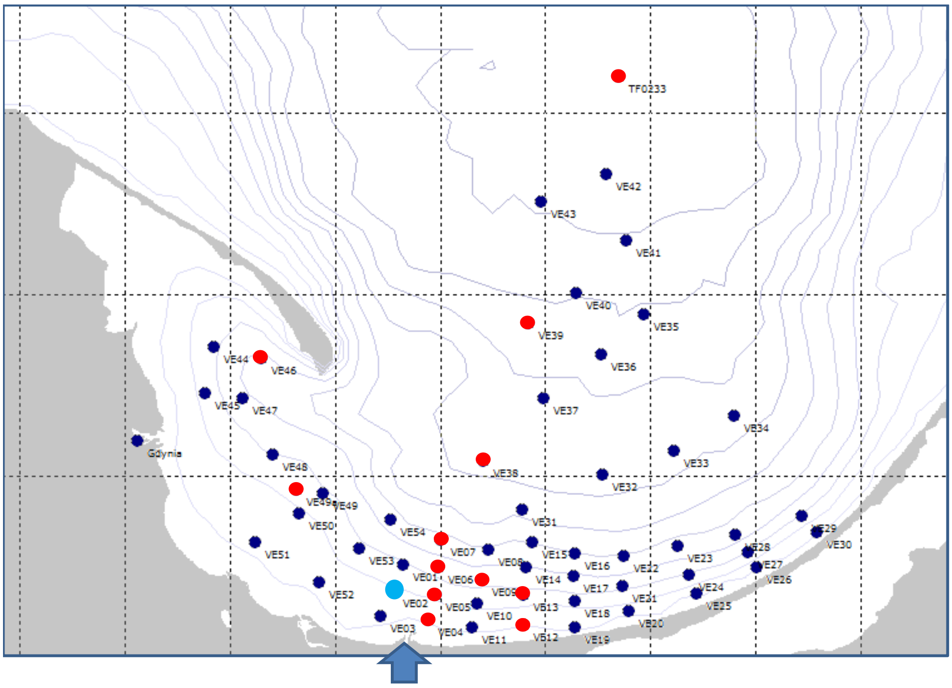

Figure 1 station map with all stations notified and the ones marked in red where samples were collected. The light blue station is mooring station VE02.

Station list

Station	Datum	PositionLat	PositionLon	Equipment	
AL449/001-1	01.02.2015	54° 23,48' N	18° 59,55' E	CTD/rosette water sampler	
AL449/001-4	01.02.2015	54° 23,51' N	18° 59,57' E	Multi corer	
AL449/001-10	01.02.2015	54° 23,51' N	18° 59,56' E	Van Veen grab	
AL449/002-1	01.02.2015	54° 22,15' N	18° 58,86' E	CTD/rosette water sampler	
AL449/002-2	01.02.2015	54° 22,14' N	18° 58,84' E	Multi corer	
AL449/002-5	01.02.2015	54° 22,12' N	18° 58,84' E	Van Veen grab	
AL449/003-1	01.02.2015	54° 25,00' N	18° 59,86' E	CTD/rosette water sampler	
AL449/003-3	02.02.2015	54° 24,97' N	18° 59,85' E	Multi corer	
AL449/003-11	02.02.2015	54° 24,98' N	18° 59,87' E	Van Veen grab	

AL449/004-1	02.02.2015	54° 26,54' N	19° 0,07' E	CTD/rosette water sampler	
AL449/004-2	02.02.2015	54° 26,53' N	19° 0,08' E	Multi corer	
AL449/004-5	02.02.2015	54° 26,53' N	19° 0,09' E	Van Veen grab	
AL449/005-1	03.02.2015	54° 23,00' N	19° 3,59' E	CTD/rosette water sampler	
AL449/005-3	03.02.2015	54° 23,01' N	19° 3,52' E	Multi corer	
AL449/005-9	03.02.2015	54° 22,97' N	19° 3,57' E	Van Veen grab	
AL449/006-1	03.02.2015	54° 23,76' N	18° 55,29' E	CTD/rosette water sampler	
Station	Datum	PositionLat	PositionLon	Equipment	
AL449/006-3	03.02.2015	54° 23,75' N	18° 55,34' E	ADCP mooring to water	
AL449/006-4	03.02.2015	54° 23,74' N	18° 55,58' E	Bottom lander	to water
AL449/007-1	03.02.2015	54° 23,91' N	18° 55,56' E	Van Veen grab	
AL449/007-8	04.02.2015	54° 23,86' N	18° 55,55' E	CTD/rosette water sampler	
AL449/007-10	04.02.2015	54° 23,84' N	18° 55,54' E	Multi corer	
AL449/007-18	04.02.2015	54° 23,81' N	18° 55,57' E	CTD/rosette water sampler	
AL449/007-19	04.02.2015	54° 23,77' N	18° 55,58' E	Bottom lander	on board
AL449/007-20	04.02.2015	54° 23,83' N	18° 55,33' E	ADCPmooring on board	on board
AL449/008-1	05.02.2015	54° 52,00' N	19° 17,00' E	CTD/rosette water sampler	
AL449/008-3	05.02.2015	54° 51,97' N	19° 17,05' E	Multi corer	
AL449/008-6	05.02.2015	54° 51,99' N	19° 17,09' E	Van Veen grab	
AL449/009-1	05.02.2015	54° 38,41' N	19° 8,41' E	CTD/rosette water sampler	
AL449/009-2	05.02.2015	54° 38,43' N	19° 8,40' E	Multi corer	
AL449/009-6	05.02.2015	54° 38,43' N	19° 8,40' E	Van Veen grab	
AL449/010-1	05.02.2015	54° 30,88' N	19° 4,09' E	CTD/rosette water sampler	
AL449/010-3	05.02.2015	54° 30,92' N	19° 4,07' E	Multi corer	
AL449/010-5	05.02.2015	54° 30,91' N	19° 4,05' E	Van Veen grab	
AL449/011-1	06.02.2015	54° 24,34' N	19° 3,94' E	CTD/rosette water sampler	
AL449/011-2	06.02.2015	54° 24,30' N	19° 4,03' E	Multi corer	
AL449/011-7	06.02.2015	54° 24,35' N	19° 4,01' E	Haps Corer	
AL449/011-23	06.02.2015	54° 24,35' N	19° 4,01' E	Van Veen grab	
AL449/012-1	06.02.2015	54° 23,47' N	19° 7,90' E	CTD/rosette water sampler	
AL449/012-2	06.02.2015	54° 23,48' N	19° 7,87' E	Haps Corer	
AL449/012-4	06.02.2015	54° 23,47' N	19° 7,87' E	Multi corer	
AL449/012-7	06.02.2015	54° 23,49' N	19° 7,88' E	Van Veen grab	
AL449/012-11	06.02.2015	54° 23,49' N	19° 7,88' E	CTD/rosette water sampler	
AL449/014-2	07.02.2015	54° 29,40' N	18° 46,28' E	Haps Corer	

AL449/015-1	07.02.2015	54° 36,45' N	18° 42,98' E	CTD/rosette water sampler	
AL449/015-3	07.02.2015	54° 36,43' N	18° 42,96' E	Multi corer	
AL449/015-5	07.02.2015	54° 36,47' N	18° 42,97' E	Van Veen grab	
AL449/016-1	09.02.2015	54° 23,72' N	18° 55,60' E	ADCP mooring to water	
AL449/016-2	09.02.2015	54° 23,82' N	18° 55,56' E	Mini Lander	to water
AL449/016-3	09.02.2015	54° 23,65' N	18° 55,56' E	CTD/rosette water sampler	
AL449/016-5	09.02.2015	54° 23,79' N	18° 55,46' E	Van Veen grab	
AL449/016-9	09.02.2015	54° 23,78' N	18° 55,40' E	CTD/rosette water sampler	
AL449/016-10	10.02.2015	54° 23,81' N	18° 55,58' E	Mini Lander	on board
AL449/016-11	10.02.2015	54° 23,73' N	18° 55,60' E	ADCP mooring on board	
AL449/016-12	10.02.2015	54° 23,79' N	18° 55,56' E	CTD/rosette water sampler	
AL449/016-13	10.02.2015	54° 23,80' N	18° 55,47' E	Multi corer	